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(54) [Name of the Invention]

Metal part Used in Semiconductor Devices, Its Manufacturing method and Semiconductor Device

(57) [Summary]

[Structure]

A metal part used in semiconductor devices that is equipped with a metal base 10, which is formed as one body from an alloy that contains 20 ~ 50 volume % of Cu and 1 weight % or less of Ni, and where the remaining part is W and/or Mo, and with a metal frame body 2. In the molded (formed) body that is obtained from the metal powder, which contains less than 1 weight % Ni powder and where the remaining part is W powder, Mo powder, a mixed powder of W and M, or a W – Mo alloy powder, Cu is impregnated and the structure is formed from the obtained by that metal composition.

[Results]

The part has good thermal diffusion properties, and it has a thermal expansion coefficient that is close to that of the housed in it semiconductor or other ceramic or glass parts, and high reliability properties and dimensional precision are practically realized. Because of the fact that a post processing is almost unnecessary it is possible to lower the manufacturing costs.

[Scope of the Claims]

[Claim 1]

A metal part used in semiconductor devices characterized by the fact that it is a metal part used in semiconductor devices that is equipped with a metal base, which houses the semiconductor device and a metal part, which is formed as one body with the above

described metal base, where the above described metal base and metal part have a structure made from an alloy material, which contains 20 ~ 50 volume % of Cu, and 1 weight % or less Ni, with the remaining part being W and/or Mo, and where it has at least one surface, which is a surface that is not mechanically processed, and the Cu content of the surface most layer part of this surface is lower than the contained amount of Cu in the inner part.

[Claim 2]

A metal part used in semiconductor devices according to the above described Claim paragraph 1 characterized by the fact that the above described alloy has a metal composition that is formed as inside a porous molded material of metal powder, which is an alloy powder containing 1 weight % or less Ni, while the remaining part is W powder, Mo powder, a mixed powder material of W and Mo, or an alloy powder of W – Mo, Cu has been impregnated.

[Claim 3]

A manufacturing method for the production of metal part used in semiconductor devices characterized by the fact that a metal powder comprised of 1 weight % or less Ni, while the remaining part is W powder, Mo powder, a mixed powder material of W and Mo, or an alloy powder of W – Mo, is molded by injection molding and after that a porous molded material is formed, which contains porosity in an amount in the range of 20 ~ 50 volume %, and in the pores of this porous molded material Cu is impregnated (infiltrated) and it is made into a composite alloy material where the shrinking coefficient of each the final dimensions of each part are within 2 %.

[Claim 4]

A manufacturing method for the production of metal part used in semiconductor devices according to the above described Claim paragraph 3 characterized by the fact that the molding technological process for the formation of the above described porous molded material contains the following processes: the technological process whereby a mixed powder material is produced as Ni powder material and at least one type of W powder material, Mo powder material, and W – Mo alloy powder material, which have correspondingly an average particle diameter of no more than 40 microns or less, are mixed so that the amount of the Ni powder becomes less than 1 weight %; the technological process whereby the above mixed powder material is mixed and kneaded together with an organic binder, which is comprised of a wax component that has a melting point of 100oC or lower, and an organic material that does not have a residual ash component; the technological process whereby the above described kneaded material is molded through an injection molding process and the technological process whereby the molded material is subjected to a treatment removing the binder material and porosity is formed.

[Claim 5]

A manufacturing method for the production of metal part used in semiconductor devices according to the above described Claim paragraph 4 characterized by the fact that the above described binder removal treatment technological process includes the technological process where vapors of organic solvent are used and a washing treatment is conducted, and the technological process whereby a thermal treatment is conducted at a temperature that is at least 500oC or higher.

[Claim 6]

A manufacturing method for the production of metal part used in semiconductor devices according to any 1 of the above described Claim paragraphs 3 ~ 5 characterized by the fact that prior to the above described Cu impregnation technological process, a technological process is included whereby on the surfaces of the above described porous molded material except for at least one surface, the mixed with solvent, powder material, which has stable physical and chemical properties at the time of the impregnation treatment, which does not react with the above described porous material, which is not wetted by the molten Cu, and which is removable easily after the impregnation treatment, is coated and dried, and after the technological process where the Cu impregnation is conducted, the technological process is included the above described powder material is removed.

[Claim 7]

A manufacturing method for the production of metal part used in semiconductor devices according to the above described Claim paragraph 6 characterized by the fact that the above described powder material is a material that contains at least one type of powder that is selected from the group of Al_2O_3, TiO_2, SiO_2, ZrO_2, AlN, BN, Si_3N_4, TiN, ZrN, SiC, ZrC and TiC.

[Claim 8]

Semiconductor device that is characterized by the fact that it uses a metal part according to the above reported Claim paragraphs 1 or 2.

[Detailed Explanation of the Invention]

[0001]

[Technical Field of the Invention]

the present invention is about a metal part used in semiconductor devices, its manufacturing method and a semiconductor devising utilizing the above metal part used for semiconductor devices. In more details, the present invention is an invention about a metal part, which is a case used for semiconductor devices like photo diodes and laser diodes used for light generation/light receiving, and microwave devices used for

communication, high output electric sources, etc., is a base plate used for housing semiconductors, and is a header etc., and this metal part has good thermal diffusion properties, it has a thermal expansion coefficient that is close to the housed semiconductor materials and to other ceramic and glass parts, and through this metal part high reliability properties and dimensional stability properties are practically realized; and it is an invention about a manufacturing method that can suggest the inexpensive manufacture of these metal parts and it is an invention about the semiconductor device using this metal part.

[0002]

[Previous Technology]

In the case of the metal casing used for the semiconductor devices that are used in optical communication, microwave communication, and high output electric sources, usually, these are provided with a base, which houses the laser diode or the microwave device, and with a metal frame body where glass terminals (pins) or ceramic pins etc., electric signal input/output terminals can be attached. Especially, in the case of metal case used for semiconductor devices containing light receiving/light generating elements, it has a structure that is formed so that the metal frame body is then provided with a window used for the input/output of the optical signal, and the housed photodiode or laser diode, through this window, can be optically connected with the optical fiber. Figure 2 and Figure 3, correspondingly show one example of the assembled body of the metal case used for semiconductor devices according to the previous technology.

[0003]

Figure 2 and Figure 3 represent correspondingly the three-dimensional view diagrams of the assembled body of the metal case used for semiconductor devices where the electric signal input/output terminals (pins) are ceramic pins, and of the assembled body of the metal case used for semiconductor devices where the electric signal input/output terminals (pins) are glass pins. This assembled body 1 of metal casing used for semiconductor devices, in each case, has a structure that is formed mainly from the metal base 10, which has the assembly opening 6 that is used for the installation, and from the metal frame body 2, which is fixed on the metal base 10 so that a box body is formed, and on the metal the casing used for semiconductor devices the electric signal input/output pins 3 are attached. A semiconductor element can be housed on the top of the metal base inside the metal frame body a laser diode or a microwave device etc. In the case when the metal casing is a metal casing used for optical communication semiconductor devices housing photodiodes or laser diodes, on the front surface of the metal frame body 2 the optical signal input/output window 4 is provided, and also, on the side surface correspondingly the electric signal input/output terminal 3 is provided. The number of the terminals is freely selected in correspondence with the number of electric signal inputs/outputs of the laser diode module. On the top edge part of the metal frame body 2 the electric signal input/output terminal 3 is fixed, and also, the metal edge 5 is attached in order to provide an airtightly sealing cover.

[0004]

Regarding the metal frame body 2, it is desirable that its thermal expansion coefficient is close to that of the glass terminals or the ceramic terminals, and also because of the fact that it has a complex shape it is desirable that it is a body that has good rigidity and processing properties. Then, because of the fact that a certain degree of rigidity properties are required, in the past, usually, iron – nickel alloy or iron – nickel – cobalt alloys have been used. On the other hand, in the case of the metal base 10, it is necessary that the heat generated by the laser diode is quickly diffused and because of that copper, copper – tungsten alloys etc., high thermal conductivity alloys have been used. The metal base 10 and the metal frame body 2 have been joined by using silver – copper alloy etc., metal solder type materials.

[0005]

As it has been described here above, in the case of the metal casing used for semiconductor devices according to the present invention, the structure has been formed from the metal base 10 and metal frame body 2 obtained from correspondingly different metals that have been joined by a solder welding. However, in the case of the metal casing used for semiconductor devices according to the previous technology that has a structure formed from the metal base 10 and metal frame body 2 obtained from correspondingly different metals, due to the mismatch of the thermal expansion coefficients of the two types of metals, at the time of the welding, it has been easy to generate deformations, and especially it has been easy to generate waviness deformation in the metal base.

[0006]

If a laser diode is placed and installed in this metal casing with generated deformations in it, a deviation of the optical axes of the laser diode and the optical fiber that is attached in the vicinity of the window part of the metal frame body, and there is the problem that it is said that the output of the laser that is entering the optical fiber is decreased. Also, in the case when a microwave device is placed, due to the waviness (warping) the device is damaged and this causes an instability of the grounding voltage and a decrease of the thermal diffusivity properties, and it is said that the device does not function properly.

[0007]

In order to solve these problems, in the previous technology, there have been additional operations that have been conducted, such as the operation where after the solder attach, the back surface of the metal base of the metal casing is polished (ground) and made to be flat, and the deformations (waviness) is corrected etc., however these operations have had poor efficiency. Also, in order not to generate the above-described deformations, the process has been considered where the metal base 10 and the metal frame body 2 are manufactured as one body from the same material. However, in this case, as this material

it has been possible to use copper – tungsten alloy, which has a thermal expansion coefficient that is close to that of glass or ceramic, and also, which has good thermal diffusion properties. In the case of the copper – tungsten alloy it can be manufactured according to the powder metal casting method, and especially, the described here below two methods can be used. In the case of the first method, it is annealing bonding method whereby the predetermined composition Cu powder and W powder are mixed and made into a molded material and after that an annealing/bonding is conducted at a temperature that is at or above the Cu melting point. Also, the second method is the impregnating (infiltration) method whereby in advance the W powder is molded and after that this material is annealed/bonded and a porous material is prepared, and molten Cu is impregnated into the pores of this porous molded material.

[0008]

According to the above-described annealing/bonding method the shrinkage coefficient obtained at the time of the annealing is large at, at least 10 % or higher, and because of that the molded material is significantly deformed. Also, at the time of the annealing, on the whole outer periphery of the molded material molten Cu is exuded, and the dimensions of each part are also changed. On the other hand, even in the case of the impregnating method at the time of the impregnation with the molten material the molten Cu exudes over the whole periphery of the molded material. Then, the Cu – tungsten alloy has difficult rigidity – processing properties. Also, regarding these problems encountered during the time of manufacturing, they are exactly the same also in the case of the Cu – molybdenum alloys. Consequently, for example, in the manufacturing of the shown according to Figure 2 and Figure 3 metal base 10 and the metal frame body 2 unified body product, there is only the method of mechanical processing and scraping off from the block of the copper – tungsten alloy and the cost becomes high and not only that but also the large scale manufacturing feasibility properties are poor.

[0009]

On the other hand, in the case of the metal header used for semiconductor devices, on the base housing laser diodes or microwave devices electric signal input/output glass terminals are attached and installed. Also, optionally (depending on the requirements) circuit base boards manufactured from ceramics are housed and in the case when in order to maintain gas tightness it is necessary to weld a cover, on the upper edge of the base a metal edge formed from an iron type metal is provided. In Figure 4 and Figure 5, correspondingly, one example of the assembled body of the metal header used in semiconductors is presented.

[0010]

Figure 4 is a three-dimensional diagram of metal header used in laser diodes, Figure 5 is a three-dimensional diagram of metal header used in microwave devices. In the case of either of these metal headers, they are parts where on the metal base 10, which is provided with the protruded part 7 used for housing semiconductor elements like laser

diodes or microwave devices etc., the electric signal input/output terminals 3, which have a structure formed from glass terminals, are attached. Regarding the number of these terminals (pins), it can be freely selected based on the number of the inputs/outputs of the semiconductor material elements, and also it is a part where on the upper edge part of the metal base 10 the metal edge 5 has been attached in order to weld the cover used for providing the gas tightness properties.

[0011]

For the metal base 10 the thermal expansion coefficient is made ro be close to that of the glass element and also, it is necessary that the heat that is generated by the semiconductor element be quickly diffused, and because of that, usually, copper – tungsten alloy is used. However, even in the case when such metal base used for metal header is manufactured by using copper – tungsten alloy, the above described deformations and exuding Cu, at the time of the annealing/bonding still occur and because of that in order to finish the parts to the predetermined dimensions it is necessary to conduct a mechanical processing of the outer periphery part, of the protruded parts used for the housing of the semiconductor material elements or the opening parts for the glass terminals, and this becomes extremely expensive.

[0012]

The manufacturing method employing the powder casting method of copper – tungsten alloy or copper – molybdenum alloy, which is used for metal parts for the above described metal parts used for semiconductor devices, has been described according to the invention in the Japanese patent Application laid Open Number Showa 59-21032. Also, in the description of the invention reported in the Japanese patent Application Hei-Sei 2-501316, a press casting method (injection molding method) has been described, which is an improvement of the above described sintering/bonding method.

[0013]

In the case of the method that has been disclosed according to the above described Japanese Patent Application Number Hei-Sei 2-501316, it is a method where Cu powder and W powder are mixed with organic binder material and a molded material is produced by using an injection molding method, and after that the binder is removed, sintering/bonding is conducted and the alloy is obtained. However, this method has the already explained drawbacks of the sintering/bonding method. First, according to this method, in order to obtain an alloy with the predetermined density, it is necessary to generate the shrinkage corresponding to the amount of the binder that is contained in the porous molded material. Consequently, in the case of the manufactured product where the shape is complex, as in the case of metal parts used for semiconductor devices, depending on the position of the part small differences in the shrinkage coefficient are generated, and at the time of the sintering/bonding, it is easy for deformations to be generated and because of that it is difficult to obtain a high precision of the shape.

[0014]

Also, in the porous molded material, the Cu powder material is contained in an amount in the range of 5 ~ 50 weight % and because of that at the time of the sintering/bonding at the surface of the porous molded material a large amount of Cu is exuded. Consequently, in the case of the manufacturing of metal casing, metal header, etc., manufactured parts, which require a high dimensional precision and surface shape, it is necessary to subject almost the whole surface to a finishing scraping off processing.

[0015]

Then, in the case of the sintering/bonding method, it is impossible to avoid that pores remain in the alloy. Because of that in the plating technological process, which follows the above described scraping off technological process, poor plating occurs because of there is poor adhesion of the plating, and there is a generation of change of the color caused by the plating solution remaining inside the pores, and areas where there is no plating inside the pores, etc. Also, because of the pores, in the space between the casing and the cover, the air tightness properties, between the other material at the opening part of the casing and the joining part, etc., can be lost. In addition to that, there is also the problem that it is said that because of the porosity the heat conductivity of the alloy is decreased.

[0016]

On the other hand, in the case of the melt impregnating method, there is almost no porosity remaining and because of that it is possible to circumvent the problems caused by the porosity. However, even in the case of the melt impregnating method, after the molding, in order to manufacture a porous molding material a sintering/bonding is conducted and even though it is not as high as in the case of the sintering/bonding method, shrinkage occurs at least at a rate of 5 % and because of that deformations are generated. Also, as it has been described here above, the molten Cu is exuded over the whole outer periphery. If such deformations and leaks are present, it is necessary that the whole surface be scraped off and a large mechanical processing finishing is required. This is a more significant problem in the case of manufactured parts with a complicated shape and even if injection molded material from W or Mo powder material is manufactured, in order to produce the porous molded material sintering/bonding is performed and the Cu melt/impregnation is conducted according to the melt impregnation method of the previous technology and it is not possible to eliminate and avoid the problems.

[0017]

[Problems Solved by the Present Invention]

The problem according to the present invention is to solve the various types of problems that have been described here above of the previous technology using the

sintering/bonding method and the melt/impregnation method in the manufacturing of manufactured parts from copper – tungsten alloys or copper – molybdenum alloys. Also, the goal of the present invention is to solve the above described problems of the previous technology and to suggest a novel metal part used for semiconductor devices, to suggest its manufacturing method and to suggest a high reliability properties possessing semiconductor device, which uses this metal part used in semiconductor devices.

[0018]

[Measures in Order to Solve the Problems]

According to the present invention a metal part used in semiconductor devices is suggested that is characterized by the fact that it is a metal part used in semiconductor devices that is equipped with a metal base, which houses the semiconductor device and a metal part, which is formed as one body with the above described metal base, where the above described metal base and metal part have a structure made from an alloy material, which contains 20 ~ 50 volume % of Cu, and 1 weight % or less Ni, with the remaining part being W and/or Mo, and where it has at least one surface, which is a surface that is not mechanically processed, and the Cu content of the surface most layer part of this surface is lower than the contained amount of Cu in the inner part. In the case of the metal part used in semiconductor devices according to the present invention it is preferred that the above described alloy has a metal composition that is formed as inside a porous molded material of metal powder, which is an alloy powder containing 1 weight % or less Ni, while the remaining part is W powder, Mo powder, a mixed powder material of W and Mo, or an alloy powder of W – Mo, Cu has been melt/impregnated.

[0019]

Also, according to the present invention a manufacturing method for the production of metal part used in semiconductor devices is suggested that is characterized by the fact that a metal powder comprised of 1 weight % or less Ni, while the remaining part is W powder, Mo powder, a mixed powder material of W and Mo, or an alloy powder of W – Mo, is molded by injection molding and after that a porous molded material is formed, which contains porosity in an amount in the range of 20 ~ 50 volume %, and in the pores of this porous molded material Cu is melt/impregnated (infiltrated) and it is made into a composite alloy material where the shrinking coefficient of each the final dimensions of each part are within 2 %. According to the method of the present invention, it is preferred that the molding technological process for the formation of the above described porous molded material contains the following processes: the technological process whereby a mixed powder material is produced as Ni powder material and at least one type of W powder material, Mo powder material, and W – Mo alloy powder material, which have correspondingly an average particle diameter of no more than 40 microns or less, are mixed so that the amount of the Ni powder becomes less than 1 weight %; the technological process whereby the above mixed powder material is mixed and kneaded together with an organic binder, which is comprised of a wax component that has a melting point of 100oC or lower, and an organic material that does not have a residual

ash component; the technological process whereby the above described kneaded material is molded through an injection molding process and the technological process whereby the molded material is subjected to a treatment removing the binder material and porosity is formed.

[0020]

According to the method of the present invention it is preferred that the above described binder removal treatment technological process includes the technological process where an organic solvent is used and a treatment of evaporation and washing is conducted, and the technological process whereby a thermal treatment is conducted at a temperature that is at least 500oC or higher. Also,

[0021]

On the other hand, according to the method of the present invention it is preferred that prior to the above described Cu melt/impregnation technological process, a technological process is included whereby on the surfaces of the above described porous molded material except for at least one surface, the mixed with solvent powder material, which has stable physical and chemical properties at the time of the impregnation treatment, which does not react with the above described porous material, which is not wetted by the molten Cu, and which is removable easily after the impregnation treatment, is coated and dried, and after the technological process where the Cu impregnation is conducted, the technological process is included the above described powder material is removed. It is preferred that the above described powder material is a material that contains at least one type of powder that is selected from the group of Al_2O_3, TiO_2, SiO_2, ZrO_2, AlN, BN, Si_3N_4, TiN, ZrN, SiC, ZrC and TiC.

[0022]

[Effect]

In the case of the metal part used in semiconductor devices according to the present invention, the metal casing and the metal part have a structure that is formed from an alloy material, which contains 20 ~ 50 volume % Cu and 1 weight % or less of Ni, and the remaining part is W and/or Mo. Consequently, the metal part used in semiconductor devices according to the present invention has high heat diffusion properties and it has a thermal expansion coefficient that is close to that of glass or ceramic.

[0023]

At the time when in the alloy material that is used for the metal part used in semiconductor devices according to the present invention the content of Cu is less than 19 weight %, the generation of pores between the particles is easy and because of that the densification is difficult, and as a result from that the thermal conductivity is deteriorated and a stable alloy is not obtained and due to that it is not appropriate as a metal casing or

header part product. Also, if the Cu content exceeds 49 weight %, the thermal expansion coefficient exceeds 10 x 10^{-6}/oC, and because of that the difference with the thermal expansion coefficient of the assembled into the metal casing or header electric signal input/output glass terminals or ceramic terminals becomes large, and this causes a decrease of the reliability properties.

[0024]

Regarding the alloy that is used in the metal part used in semiconductor devices according to the present invention, it is also a good option if it contains 1 weight % Ni or less. This is because of the fact that because of the Ni at the time of the Cu melt/impregnation the wetting properties with the porous molded material are improved, however, if the Ni content exceeds 1 weight %, the thermal conductivity of the alloy is decreased and that is not preferred. Regarding the alloy that is used in the metal part used in semiconductor devices according to the present invention, excluding the above described Cu and Ni, the remaining part is W and/or Mo, and the ratio of W to Mo can be freely adjusted.

[0025]

Regarding the metal part used in semiconductor devices according to the present invention, it is preferred that the above described alloy has a metal composition that is formed as inside a porous molded material of metal powder, which is an alloy powder containing 1 weight % or less Ni, while the remaining part is W powder, Mo powder, a mixed powder material of W and Mo, or an alloy powder of W – Mo, Cu has been melt/impregnated. The W, Mo and Ni form the skeleton of the porous molded material and the Cu is impregnated inside the pores. Consequently, through the W, Mo, Ni skeleton and the Cu impregnation phase a specific composite structure/composition is formed.

[0026]

According to the present invention when the above described metal part used in semiconductor devices is manufactured as the powder injection molding and the melt impregnation methods are combined, by that the dimensional stability is markedly increased and the manufacturing costs are decreased. Namely, according to the method of the present invention it is preferred that the described here below structural elements are contained.

(1) The porosity that is generated after the binder removal in the molded material manufactured by the injection molding method and that has as its main components W or Mo is used constructively as the porosity that is melt impregnated with Cu. By that the requirement for the removal of the porosity and increase of the density which has been used according to the sintering/bonding technological process conducted according to the previous technology after the injection molding, is not present and it is possible to constrain the shrinkage of the

molded material to a maximum of 2 %. Consequently, the dimensional precision of the molded materials that are manufactured according to the injection molding process can be maintained.

(2) In order to conduct a complete removal of the binder from the material that has been molded in a three-dimensionally complex shape and has been manufactured by injection molding and to reliably conduct the Cu melt/impregnation, a two step treatment is conducted consisting of the washing treatment by using organic solvent vapor and a heat treatment process.

(3) In order to minimize as much as possible the mechanical processing that has been necessary after the Cu melt/impregnation according to the previous technology, in the case when after the melt/impregnation a mechanical treatment is conducted on the porous molded material after the binder removal, an agent preventing the exuding is coated with the exception of the surface that presumably is the easiest to process (for example, in the case of the metal header according to Figure 2 and Figure 3, the 1 edge surface of the base 10)and the Cu melt/impregnation is conducted from the surface of the porous molded material that is presumed to be the easiest to process. By that, the Cu leakage occurs only from the easiest to process surface of the porous molded material that has been melt impregnated and the Cu selectively is exuded from that surface. Consequently, according to the method of the present invention if the dimensional precision is satisfied there is no requirement for processing of the other surfaces. In this case there is also little scraping. Consequently, the time period for the processing in order to complete the finishing is significantly shortened. According to the method of the present invention by appropriately compounding the above described essential structural components, a high precision metal part is manufactured that is comprised of a Cu-W, Cu-Mo, Cu-W-Mo.

[0027]

In more details, according to the method of the present invention, a metal powder that is formed from a mixed powder that contains 1 weight % or less Ni, and where the remaining part is W powder, Mo powder, a W and Mo mixed powder or a W – Mo alloy powder, is molded by injection molding and because of that it is possible to suggest a molded material with a three-dimensionally complex shape that has a high precision and is inexpensive. Consequently, it is appropriate for the manufacturing of metal parts like metal casing used for laser diodes or metal headers used for microwave devices, etc., which have a complex shape, and also, where a high dimensional precision and high thermal diffusivity are required.

[0028]

Also, according to the method of the present invention after the metal powder has been molded, a porous molded material is formed that has a residual porosity in the range of 20 ~ 50 volume %, and in this porosity, Cu is melt impregnated. According to this

method as in the case of the usual injection molding method, binder removal is conducted and after that powder sintering is not conducted and because of that through the technological process from the porous molded material obtained from the injection molding to the finished part product, there is no significant shrinkage of the porous molded material and the molding metal die is designed at a high precision and by that it is possible to control to high precision level the dimensional precision of the finished part product.

[0029]

According to the method of the present invention, in the case when the porosity of the above described porous molded material is less than 20 volume %, it is easy for the Cu content after the melt impregnation to become less than 20 volume % and when that happens because of the generation of internal pores there is variation in the thermal conductivity and a stable alloy is not obtained. On the other hand, if the porosity exceeds 50 volume %, the Cu content after the melt impregnation exceeds 50 volume % and the thermal expansion coefficient exceeds 10×10^{-6}/oC. Consequently, the porosity of the above described porous molded material is made to be within the range of 20 ~ 50 volume %.

[0030]

According to the method of the present invention the molding technological process for the formation of the above described porous molded material contains the following processes: the technological process whereby a mixed powder material is produced as Ni powder material and at least one type of W powder material, Mo powder material, and W – Mo alloy powder material, which have correspondingly an average particle diameter of no more than 40 microns or less, are mixed so that the amount of the Ni powder becomes less than 1 weight %; the technological process whereby the above mixed powder material is mixed and kneaded together with an organic binder, which is comprised of a wax component that has a melting point of 100oC or lower, and an organic material that does not have a residual ash component; the technological process whereby the above described kneaded material is molded through an injection molding process and the technological process whereby the molded material is subjected to a treatment removing the binder material and porosity is formed. Through adjustment of the amount of this binder at the time of the mixing and kneading of this binder, it is possible to easily make the porosity of the porous molded material be within the range of 20 ~ 50 volume %.

[0031]

According to the method of the present invention in the case when Ni is contained in the above described mixed powder material, as described here above the Cu impregnation properties (the wetting properties relative to the porous molded material) are increased. However, if the amount of Ni contained in the mixed powder material exceeds 1 weight %, the thermal conductivity after the melt impregnation is decreased and because of that it is not preferred.

[0032]

According to the method of the present invention, regarding the used as raw material Ni, W, Mo, W-Mo alloy powder, in order to increase the density of the porous molded material and to allow the homogeneous melt penetration of Cu in the predetermined porosity part, a material that has an average particle diameter that is no more than 40 microns, or less, is used. Then, it is preferred to use a material that has an average particle diameter that is no more than 10 microns or less.

[0033]

According to the method of the present invention, it is preferred that the binder removal treatment technological process includes the technological process where vapors of organic solvent is used and a washing treatment is conducted, and the technological process whereby a thermal treatment is conducted at a temperature that is at least 500oC or higher. According to the method of the present invention, the binder that is mixed and kneaded into the above described mixed metal powder material is an organic binder obtained as a low melting point wax and a organic material, which does not contain a residual ash component, are mixed. This organic material is a stable organic material at the melting point of the wax. In the above described binder removal process, by the technological process where the first step washing using organic solvent vapors is conducted, the was component is removed and because of that a binder removal close to the surface is conducted and together with that guiding pores are formed in order to remove the above described organic material from the inner part of the molded material. After that, by performing the second step thermal process this organic material is destructed and eliminated.

[0034]

As the organic solvent used for the above described vapor washing technological process, it is preferred to use an organic solvent that has a boiling point lower than the organic binder melting point or softening point. This is in order to prevent the deformation of the molded material at the time of the vapor washing. As such organic solvents, for example, ethanol, acetone, tri-chloro-ethane, carbon tetra chloride, methylene chloride, etc., can be used.

[0035]

On the other hand, regarding the above described thermal technological process, as much as possible, it is preferred to be practically conducted in an ambient atmosphere that does not contain oxygen. This is done in order to prevent the molded material from oxidation, and for example, it is preferred that the above described thermal technological process be conducted in a hydrogen gas ambient atmosphere.

[0036]

According to the method of the present invention, in order to prevent the exuding of Cu over the whole surface at the time of the melt impregnation with Cu, and to have Cu be exuded selectively only on the surface that is the easiest for processing in the case of mechanical processing of the molded material after the melt impregnation, prior to the Cu melt impregnation technological process, on the surface of the porous molded material with the exception of the above described surface a powder material that prevents melt impregnation and that has been dispersed in water or an organic agent is coated and applied and then dried. Regarding this powder material, it is necessary that it is a powder that is chemically and physically stable at the time of the melt impregnation treatment and that it does not react with the above described porous molded material, and that it is not wetted by the molten Cu, and that it is easily removable after the melt impregnation treatment. As preferred materials that can be used as melt impregnation preventing powder materials, it is possible to use Al_2O_3, TiO_2, SiO_2, ZrO_2, AlN, BN, ZrN, Si_3N_4, TiN, SiC, ZrC, and TiC.

[0037]

According to the method of the present invention, a mixed powder material, which does not contain Cu, which contains 1 weight % or less Ni, and where the remaining part is W powder, Mo powder, W and Mo mixed powder, or W – Mo alloy powder is mixed and kneaded with an organic binder material, and it is molded using injection molding. Because of the fact that according to this method, the molded material is molded and after that the binder material is removed, and in the obtained porosity Cu is melt impregnated, it is not necessary to generate the shrinkage that corresponds to the binder part according to the method of the previous technology. Consequently, the porous molded material has almost no shrinkage, and also, it is possible to obtain sufficient alloy density. Even if it is an item with a complex shape, it is possible to achieve high shape precision and dimensional precision. Then, according to the method of the present invention, at the time of the Cu melt impregnation, with the exception of the surface that selectively would exude the Cu, the whole surface of the porous molded material is coated and applied with an agent preventing the leakage (leakage preventing agent). By that, it is possible to suppress the leakage of Cu towards the large part of the surface of the porous molded material. Because of that only the surface, which selectively exudes the above described Cu, is mechanically processed and consequently the other surfaces are not mechanically processed and it is possible to obtain the predetermined manufactured product shape.

[0038]

Here below, then the present invention is explained in more details by using practical examples, however, the disclosed here below is nothing more than simply practical examples of the present invention, and this description does not limit the technical field of the present invention.

[0039]

[Practical Examples]

Practical Example 1

In Figure 1 a metal casing is shown, which is used for laser diode module, and which is one example of metal parts used for semiconductor devices according to the present invention. The metal casing according to Figure 1 is formed from a metal base 10 and a metal frame body 2, and on the metal base 10, in front and behind the frame body 2 the attachment openings 6 are provided, which are used for fixing and installation. The metal frame body 2 has the two parts 21 and 22, which are placed at a distance so that the electric signal input/output terminals can be attached, and on the front surface of the material 21, the window 4, which is used for optical signal input/output, is provided. Here below, the manufacturing process for the preparation of the above described metal casing according to the present invention method, is described.

[0040]

Initially, W powder material with an average particle diameter of 3 microns and Ni powder material with an average particle diameter of 4 microns, are compounded so that their amounts become, correspondingly, 99.9 weight % and 0.1 weight %, and the mixed powder material is prepared. After that, wax, which has a melting point of 80oC, and polyethylene, which has a degradation/incineration temperature of 550oC, are mixed so that their ratio by volume becomes 75:25, and this material is used as the organic binder. This organic binder and the above described W, Ni powder material are mixed so that their volume ratio becomes 38:62, and by using a kneader they are mixed and kneaded. This kneaded material is introduced into an injection molding device and the porous molded material with the shape of the shown in Figure 1 metal casing used for laser diodes, is produced.

[0041]

By using methylene chloride (boiling point 40oC) this porous molded material is subjected to a 5 hour vapor washing and by that the first step binder removal was conducted and after that in a hydrogen gas atmosphere, it is heated at a temperature of 800oC for a period of 30 minutes and by that the second step binder removal treatment, was conducted. The appearance of this porous molded material, which has undergone binder removal, is good, and also, the shape was maintained, and there were no waviness, shape change, etc., deformations. Also, the porosity of this porous molded material that has undergone binder removal was 38 volume %.

[0042]

On the whole surface of the porous molded material after the binder removal, with the exception of the back surface, dispersed in water BN powder was coated at a thickness of 10 microns by using the spray method. This porous molded material was placed on a 1 mm thick copper plate that has been cut to the same length and width as that of the metal

base 10 of the metal casing used for the laser diode module, shown in Figure 1, and in a hydrogen ambient atmosphere in a continuous kiln, the copper melt impregnation was conducted at a temperature of 1150oC. When after the melt impregnation each of the dimensions were measured, the dimension shrinkage coefficient was 0.8 %. After that the coated BN powder material was removed by liquid honing and then, the remaining on the back surface molten copper was removed by polishing. The above described manufacturing conditions and alloy densities are shown in Table 1 as experimental material No. 1, and also, the thermal expansion coefficient and the thermal conductivity are shown in table 2 as the experimental material No. 1. The examples, including reference examples, of metal cases that have been manufactured according to the same manufacturing conditions as described here above besides the conditions that are reported in the same table, are also shown in Table 1 as experimental materials 2 ~ 16. Regarding the shrinkage after the melt impregnation, in the case of the experimental materials according to the present invention, the material according to the experimental material No. 10 had the highest shrinkage rate of 1.8 %. This shrinkage changes in correspondence with the porosity of the porous molded material that is found at the time of the melt impregnation. In the case of the porous molded materials with a porosity of up to 30 %, there is almost no shrinkage of the porous molded material, however, if the porosity exceeds 30 %, this shrinkage increases somewhat in correspondence with the increase of the porosity. Also, according to additional experiments by the authors of the present invention on the temperature and the time of the melt impregnation, it has been confirmed that in the case of the experimental materials according to the present invention the above described shrinkage rate reaches a maximum of 2 %. Then, there was no effect observed of this small level of shrinkage on the final Cu content and the properties of the alloy as well as on the dimensional precision.

[0043]

[Table 1]

	W/Ni比または Mo/Ni比 (重量比)	バインダー/金属粉末比 (体積比)	1次脱バインダー処理で使用した有機溶媒	2次脱バインダー処理の加熱温度	多孔成形体の空孔率 (体積%)	使用溶出防止剤	合金密度 (n=50)	溶浸後の収縮率 (%)
1	99.9/0.1	38/62	メチレンクロライド	800℃	38	BN	15.3±0.2	0.8
2	99.0/1.0	20/80	エタノール	600℃	20	ZrO_2	17.2±0.3	0
3	99.5/0.5	20/80	メチレンクロライド	800℃	20	BN	17.2±0.3	0
4	99.6/0.4	28/72	エタノール	600℃	28	TiN	16.4±0.3	0
5	99.6/0.4	28/72	エタノール	600℃	28	Al_2O_3	16.4 ±0.3	0
6	99.7/0.3	35/65	メチレンクロライド	600℃	35	BN	15.7±0.2	0.5
7	99.7/0.3	35/65	メチレンクロライド	550℃	35	BN	15.6±0.2	0.5
8	99.8/0.2	42/58	エタノール	550℃	42	TiN	14.9±0.2	1.0
9	99.8/0.2	42/58	エタノール	600℃	42	TiN	14.9±0.2	1.0
10	99.9/0.1	48/52	メチレンクロライド	600℃	48	AlN	14.3±0.2	1.5
11	99.0/1.0	20/80	エタノール	800℃	20	BN	9.9±0.2	0
12	99.5/0.5	35/65	エタノール	600℃	35	TiN	9.8±0.2	0.2
13	99.9/0.1	49/51	メチレンクロライド	600℃	49	AlN	9.6±0.2	1.5
14	99.5/0.5	18/82	—	—	—	—	—	—
15	99.5/0.5	51/49	—	—	—	—	—	—
16	98.8/1.2	28/72	エタノール	600℃	28	Al_2O_3	6.4±0.3	0

Headings in the table: 1. W/Ni ratio or Mo/Ni ratio, 2. binder/metal powder ratio (volume ratio), 3. organic solvent used in the first step binder removal treatment, 4. heating temperature of the second step binder removal treatment, 5. porosity of the porous molded material (volume %), 6. leakage preventing agent, 7. alloy density, 8. shrinkage after the melt impregnation (%), 9. methylene chloride, 10. ethanol.

Remarks)

Experimental materials 1 ~ 10 are practical examples of manufacturing where W-Ni powder material was used. Experimental materials 11 ~ 13 are practical examples of manufacturing where Mo-Ni powder material was used. Experimental materials 14 ~ 16 are reference examples where W-Ni powder material was used. In the case of the experimental material 14 the kneaded material was not 100 % filled in the mold, and a molded material with the correct molding density was not obtained. In the case of the experimental example 15, at the time of the binder removal the molded material foamed and a correct porous molded material was not obtained.

[0044]

Regarding the alloy density, it is a parameter that was measured on 50 parts, and it was almost the theoretical density and thus it was understood that the pores after the binder removal and the sintering were completely melt impregnated with Cu. Also, the structure of the cross sectional surface had no defects, and then, on the surface that has been coated with the leakage preventing agent there was no Cu leakage observed at all. As a result of the surface analysis it was understood that through the leakage preventing agent, the Cu

content of the surface layer part (approximately 1 micron) of the surface that has been coated with the leakage preventing agent was somewhat lower compared to the internal part of the metal case, however that also had no effect on the values of the properties of the alloy material.

[0045]

The thermal conductivity and the thermal expansion coefficients of the corresponding alloys are according to the presented in Table 2, and these are materials that show properties sufficient to be used as metal parts used in semiconductor devices.

[0046]

[Table 2]

	1 熱膨張係数 ($\times 10^{-6}$/℃)	2 熱伝導率 (cal/cm sec℃)
1	8.6	0.51
2	6.5	0.39
3	6.5	0.42
4	7.2	0.45
5	7.2	0.45
6	8.3	0.48
7	8.3	0.48
8	9.1	0.55
9	9.1	0.55
10	9.7	0.63
11	8.0	0.38
12	9.0	0.49
13	10.0	0.57
16	7.2	0.30

金属ケースを使用したもの、特開平2-501

Headings in the table: 1. thermal expansion coefficient, 2. thermal conductivity.

[0047]

Practical Example 2

The dimensional precision of metal casing used for laser diode module according to 6 in Table 1, and the dimensional precision of a material manufactured according to the method of the previous technology as reported in the Japanese Patent Application

Number Hei-Sei 2-501316, at the same amount of Cu (Reference Example 1), are shown in Table 3 below.

[0048]

According to this table 3, the " weld attach back fold" indicates a fold of the assembled metal casing used for laser diode module where as shown in Figure 2 the ceramic terminal 3 and the metal edge 5 are welded. For this value only, a material using the metal casing for laser diode module according to the present invention that has been manufactured according to the method of the present invention, Table 1, 5, and a material using a metal casing manufactured according to the previous technology method as disclosed in the description of the Japanese patent Application Number Hei-Sei 2-501316 (Reference Example 1), and a material using a metal casing obtained according to the previous technology method disclosed in the Japanese Patent Application laid Open Number Showa 59-21032, where a metal base that has been obtained as a copper – tungsten alloy is subjected to mechanical processing is subjected to solder welding with a metal frame body with a structure formed from iron, nickel- cobalt alloy (Reference Example 2), are correspondingly shown.

[0049]

[Table 3]

要求寸法 (単位：mm)		金属ベース					金属枠体		
		長さ	幅	厚さ	取付穴径	ろう付後そり	長さ	幅	高さ
		32±0.15	12.7±0.1	1.0±0.05	2.64±0.05	0.015Max	20.80±0.15	12.7±0.1	8.0±0.1
本発明の寸法公差	6−1	31.96	12.71	1.01	2.64	0.005	20.80	12.71	8.03
	6−2	31.96	12.72	1.01	2.63	0.003	20.79	12.72	8.02
	6−3	32.01	12.69	1.02	2.66	0.005	20.75	12.69	7.99
	6−4	32.05	12.70	0.99	2.65	0.001	20.83	12.70	8.01
	6−5	32.02	12.68	0.98	2.62	0.003	20.85	12.68	7.97
	6−6	32.03	12.68	1.00	2.65	0.005	20.81	12.68	8.01
	6−7	31.98	12.70	1.00	2.66	0.004	20.82	12.70	8.00
	6−8	31.99	12.73	1.02	2.64	0.004	20.84	12.73	7.96
	6−9	32.00	12.71	0.98	2.62	0.003	20.81	12.71	7.99
	6−10	32.01	12.70	1.00	2.64	0.002	20.80	12.70	8.02
	平均	32.001	12.702	1.001	2.641	0.004	20.811	12.702	8.000
	R	0.090	0.050	0.040	0.040	0.004	0.090	0.050	0.070
	σ	0.028	0.015	0.014	0.014	0.001	0.025	0.015	0.021
比較例1	平均	32.010	12.69	1.00	2.65	0.012	20.81	12.69	7.99
	R	0.12	0.08	0.05	0.05	0.08	0.11	0.08	0.04
	σ	0.049	0.034	0.026	0.025	0.030	0.043	0.034	0.025
比較例2	平均	———	———	———	———	0.032			
	R	———	———	———	———	0.017			
	σ	———	———	———	———	0.048			

Headings for table: 1. required dimensions (units: microns), 2. metal base, 3. metal frame body, 4. length, 5. width, 6. thickness, 7. installation opening diameter, 8. solder attach back fold, 9. height, 10. dimensional tolerance according to the present invention, 11. average, 12. Reference Example 1, 13. Reference Example 3.

[0050]

After that the above described metal casing for laser diode module according to the present invention, and the metal casings for laser diode modules according to the Reference Example s 1 and 2, were used and as it is shown in Figure 2, the ceramic terminals 3 and the metal ridge 5 are solder welded and the assembled bodies of the metal casings for laser diode modules, were manufactured. On the front surfaces of the corresponding assembled bodies, 1.5 micron thick nickel plating was conducted and then on top of that a 1.5 micron thick gold plating was conducted, and in the window 4 a manufactured from sapphire window material was adhered and sealed by using Au-Sn solder. In this state, the plating thermal resistance properties (verification of the deteriorated state of the plating after being maintained for a period of 5 minutes at 450oC in air), the assessment of the gas tightness properties after 100 heat cycles (-65oC x 10 minutes ⇨⇦ + 150oC x 10 minutes), was conducted for 200 metal casing assembled bodies relative to the corresponding parameters.

[0051]

Regarding the thermal resistance properties, the appearance after maintaining at the above described high temperature was checked by using a 20 X power optical microscope and the swelling of the longitudinal direction edge surface of the frame body, the stain, the color change, etc., unfavorable conditions and in the case of the parts according to the previous technology, especially, the color change of the solder attach part between the base part and the frame body part, were checked. The method for the evaluation of the air tightness properties is shown according to the presented in Figure 6. The evaluation of the air tightness properties was conducted according to the method where the metal casing assembled body 1 used for laser diode module is set on a flange 41, which is used for pulling vacuum, through the O ring 42, which is placed under the metal frame body 2, and the air inside the casing is removed, and after that from the outside He gas is blown in and the He passes through the above described flange and by using a He leak detector the leak amount is verified. According to this method, the materials where the leak amount was at or less than 5×10^{-8} atm cc/sec were denoted as passing and these that had higher than that amount were denoted as failing. The corresponding results are shown in Table 4.

[0052]

[Table 4]

評価項目 1	2 実施例 (各 200個)	3 比較例 1 (各 200個)	4 比較例 2 (各 200個)
メッキの耐熱性 (上段が枠体部側面の不具合品数、	0	4	0
下段がベースと枠の間のロウ付け部の変色不具合品数)	0	0	0
ヒートサイクル後の気密性 (不合格品数)	0	2	0
サーマルショク後の気密性 (不合格数) 7	0	2	0

Headings in the table: 1. Evaluation parameters, 2. Practical Example (each 200 units), 3. Reference Example 1 (each 200 units), 4. Reference Example 2 (each 200 units), 5. thermal resistance properties of the plating (upper row, number of failed parts of the frame body part side surface, lower row, number of failures for color change between the base and the frame), 6. air tightness properties after the heat cycles (number of failures), 7. air tightness properties after thermal shock (number of failures).

[0053]

As it is shown in Table 4, in the case according to the Reference Example 1, the thermal resistance properties of the side surface of the metal frame body are poor and also there is a generation of poor heat cycling and a generation of poor thermal shock properties, and relative to that, in the case of the products manufactured according to the present invention, there were no failures at all. Moreover, in the case of the products according to the present invention, the leak rates in all cases were below 1×10^{-9} atm cc/sec. In the case of the air tightness failures generated in the heat cycle and the thermal shock according to the Reference Example 1, it is assumed that these are generated due to the porosity in the metal casing.

[0054]

After that, the same assembled bodies are used as in the above described and in reality a laser diode is placed and as it is shown according to the presented in Figure 7 by using the installation opening 6, through the bolt 24, it is pressed hard on the Cu heat dissipating plate 23 and fixed, and then, by using the optical fiber 26 it was connected to the power meter 25. Prior to this hard pressing and fixing, namely, in a state where it is lightly supported on the heat dissipating plate, and in a state where it is completely fixed, the same input light amount Wo is applied, and the output light amounts W1, W2 relative to the optical fiber before and after the fixing, are measured, and the output decrease ratio

(W1 – W2)/W1 (%) is calculated, and these results are assembled and are shown in table 5. From this data, it is understood that compared to the case of the assembled body using the metal casing according to the present invention, the assembled body using the metal casing according to the previous technology, clearly, has deformations where there are folds in the casing body itself and because of that after the hard pressing a deviation of the optical axis is generated and the decrease of the output is large.

[0055]

[Table 5]

	Metal Casing according to the present invention	Metal casing according to the Reference Example 1	Metal Casing according to the Reference Example 2
Output Decrease Ratio	1 % or less	1 ~ 7 %	1 ~ 10 %

It is understood that the semiconductor device using the metal casing according to the present invention demonstrates excellent performance compared to the devices using the metal casing according to the previous technology.

[0056]

[Results From the Present Invention]

As it has been described here above, according to the present invention a novel metal part used in semiconductor devices is suggested that has good thermal diffusion properties, that has thermal expansion coefficient that is close to that of the housed semiconductor materials or other glass and ceramic parts, and that practically realizes high reliability properties and dimensional precision; its manufacturing method and a semiconductor device using this metal part used for semiconductor devices, are suggested. The metal part according to the present invention is a part where the metal base and the other metal parts are made as one unified body and because of that it is possible to simplify the manufacturing operations. Also, the problems, which are related to the generation of folds and joining parts through the joining between the metal case and the metal frame body used according to the present invention, are eliminated. The metal parts used for semiconductor devices according to the present invention, which are manufactured according to the method of the present invention, have high dimensional precision and because of that for most of the parts additional material processing is not required and it is possible to significantly decrease the manufacturing costs. Then, by using the metal parts for semiconductor devices according to the present invention it is possible to stably manufacture semiconductor devices with high reliability.

[Brief Explanation of the Figures]

[Figure 1]

Figure 1 represents a three-dimensional diagram of the metal casing used for laser diode module, which is one example of the metal part used for semiconductor devices, according to the present invention.

[Figure 2]

Figure 2 represents a three-dimensional diagram of the assembled metal casing used for laser diode module, according to the previous technology.

[Figure 3]

Figure 3 represents another three-dimensional diagram of the assembled metal casing used for laser diode module, according to the previous technology.

[Figure 4]

Figure 4 represents a three-dimensional diagram of the metal header used for laser diode, which is one example of the metal part used for semiconductor devices, according to the present invention.

[Figure 5]

Figure 5 represents a three-dimensional diagram of the metal header used for laser diode, which is one example of the metal part used for microwave devices, according to the present invention.

[Figure 6]

Figure 6 is a diagram showing the method for the examination of the air tightness properties conducted according to the practical examples.

[Figure 7]

Figure 7 is a diagram showing the measurement method for measuring the laser output that is conducted according to the practical examples.

[Explanation of the signs]

1.....................metal casing
2.....................metal frame body
3.....................electric signal input/output terminal (pin)

4.......................window
5.......................metal ridge
6........................attachment opening
7.......................protruded part used for housing the semiconductor element
10.....................metal base

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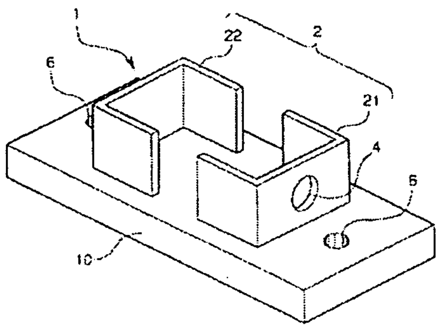
10/18/05

【図1】



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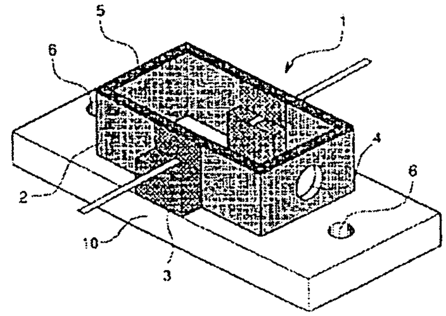

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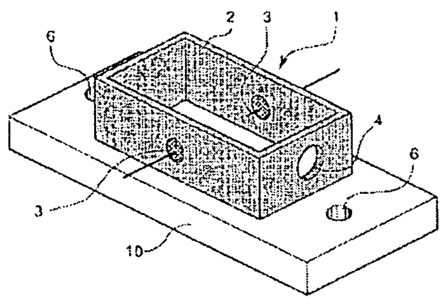
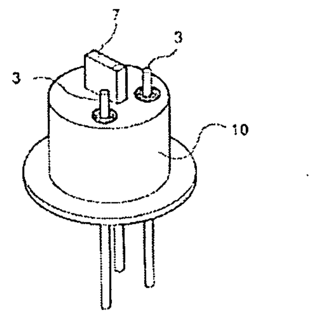


【図4】



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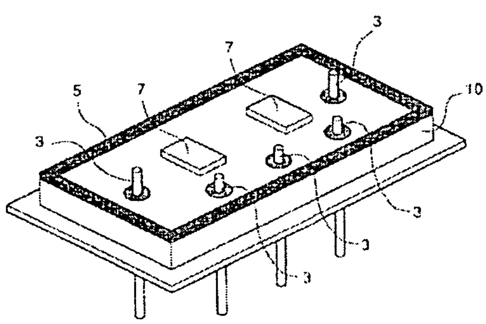

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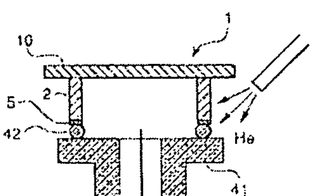

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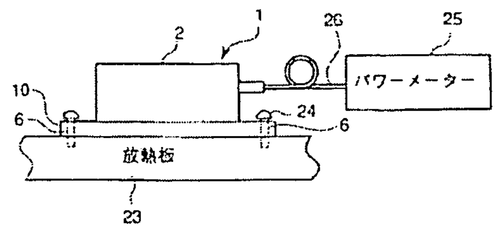

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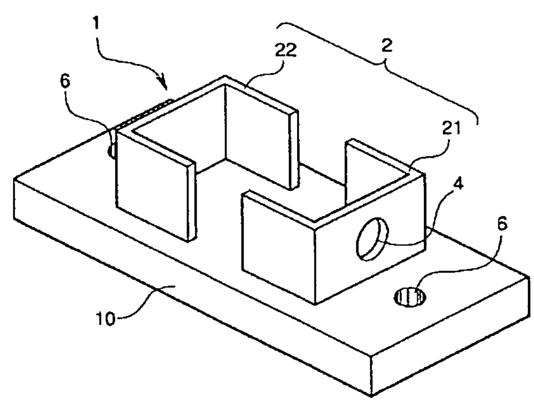
(54)【発明の名称】　半導体装置用金属部品、その製造方法及び半導体装置

(57)【要約】

【構成】　20～50体積％のCuと、１重量％以下のNiとを含み、残部がWおよび／またはMoを含む合金で一体に成形された金属ベース10と金属枠体２とを備える半導体装置用金属部品。１重量％未満のNi粉末を含み、残部がW粉末、Mo粉末、WとMoとの混合粉末またはＷ－Mo合金粉末である金属粉末の成形体にCuを溶浸して形成された金属組織で構成されている。

【効果】　良好な熱放散性、搭載する半導体や他のセラミック、ガラス部品と近似した熱膨張係数を有し、高い信頼性および寸法精度を実現している。後加工が、殆ど不要なので製造コストが低減できる。



【特許請求の範囲】

【請求項1】 半導体装置を搭載する金属ベースと、該金属ベースと一体に形成された金属部材とを備える半導体装置用金属部品において、前記金属ベースと金属部材とが、20～50体積%のCuと、1重量%以下のNiとを含み、残部がW及び／又はMoの合金で構成され、少なくとも1面の機械加工されていない面を有し、この面の極く表層部のCu含有量が内部のCu含有量以下であることを特徴とする半導体装置用金属部品。

【請求項2】 前記合金が、1重量%以下のNi粉末を含み、残部がW粉末、Mo粉末、WとMoとの混合粉末又はW－Mo合金粉末である金属粉末の多孔成形体にCuを溶浸して形成された金属組織で構成されていることを特徴とする請求項1に記載の半導体装置用金属部品。

【請求項3】 1重量%以下のNi粉末を含み、残部がW粉末、Mo粉末、WとMoとの混合粉末又はW－Mo合金粉末からなる金属粉末を射出成形法により成形した後、空孔を20～50体積%含んだ多孔成形体を形成し、この多孔成形体の空孔にCuを溶浸し、最終的な各部の寸法の収縮率を2％以内にして複合合金化することを特徴とする半導体装置用金属部品の製造方法。

【請求項4】 前記多孔成形体を形成する工程が、それぞれ平均粒径40μm以下の、Ni粉末と、W粉末、Mo粉末及びW－Mo合金粉末の少なくとも1種とをNi粉末が1重量%以下となるよう混合して混合粉末とする工程と、該混合粉末を、融点 100℃以下のワックス成分と灰分を殆ど残さない有機物を混合してなる有機バインダーと共に混練する工程と、該混練物を射出成形により成形する工程と、成形したものを脱バインダー処理して空孔を形成する工程とを含むことを特徴とする請求項3に記載の半導体装置用金属部品の製造方法。

【請求項5】 前記脱バインダー処理する工程が、有機溶媒を使用して蒸気洗浄処理する工程と、 500℃以上の温度で加熱処理する工程とを含むことを特徴とする請求項4に記載の半導体装置用金属部品の製造方法。

【請求項6】 前記Cuを溶浸する工程の前に、前記多孔成形体の少なくとも1面を除く表面に、溶浸処理時に物理的及び化学的に安定で前記多孔成形体と反応せず、溶融Cuと濡れず、溶浸処理後容易に除去可能である粉末の溶剤混合物を塗布乾燥する工程含み、Cuを溶浸する工程の後に、前記粉末を除去する工程を含むことを特徴とする請求項3～5のいずれか1項に記載の半導体装置用金属部品の製造方法。

【請求項7】 前記粉末が、Al_2O_3、TiO_2、SiO_2、ZrO_2、AlN、BN、Si_3N_4、TiN、ZrN、SiC、ZrC及びTiCから選択された少なくとも1種の粉末を含むことを特徴とする請求項6に記載の半導体装置用金属部品の製造方法。

【請求項8】 請求項1又は2に記載の金属部品を使用していることを特徴とする半導体装置。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、半導体装置用金属部品、その製造方法及びこの半導体装置用金属部品を使用した半導体装置に関する。より詳細には、光受発光用のフォトダイオードやレーザダイオード及び通信用マイクロ波デバイス、高出力電源等の半導体装置用ケース・半導体搭載用基板及びヘッダー等の金属部品であって、良好な熱放散性、搭載する半導体や他のセラミック、ガラス部品と近似した熱膨張係数を有し、高い信頼性及び寸法精度を実現した金属部品、その金属部品を安価に提供できる製造方法及びその金属部品を使用した半導体装置に関するものである。

【0002】

【従来の技術】光通信、マイクロ波通信及び高出力電源等に使用される半導体装置用金属ケースは、一般にレーザダイオードやマイクロ波デバイスを搭載するベースと、ガラス端子やセラミック端子等の電気信号入出力端子が取付可能な金属枠体とを具備する。特に、光受発光素子を含む半導体装置用金属ケースの場合には、金属枠体がさらに光信号入出力用の窓を備え、搭載されたフォトダイオードやレーザダイオードがこの窓を介して光ファイバと光学的に結合できるよう構成されている。図2及び図3にそれぞれ従来の半導体装置用金属ケースの組立体の一例を示す。

【0003】図2及び図3は、それぞれ電気信号入出力端子がセラミック端子の半導体装置用金属ケース組立体及びガラス端子の半導体装置用金属ケース組立体の斜視図である。これらの半導体装置用金属ケース組立体1は、いずれも固定用の取付穴6を有する金属ベース10と、金属ベース10上に筐体をなすよう固定された金属枠体2で主に構成されている半導体装置用金属ケースに電気信号入出力端子3を取り付けたものである。金属枠体2中の金属ベース10上にはレーザダイオードやマイクロ波デバイス等の半導体素子が搭載される。金属ケースがフォトダイオードやレーザダイオードを搭載する光通信半導体装置用の金属ケースの場合には、金属枠体2の正面には光信号入出力用の窓4が設けられており、また側面にはそれぞれ電気信号入出力端子3が取り付けられている。端子の数はレーザダイオードモジュールの電気信号の入出力数に応じて任意である。金属枠体2の上縁部には、電気信号入出力端子3を固定し、且つ気密封止するふたを接合するための金属縁5が取り付けられることもある。

【0004】金属枠体2は、ガラス端子やセラミック端子と熱膨張係数が近似していることが望ましく、また、形状が複雑であるので、塑性加工性の良いことが望まれる。さらに、ある程度の剛性が必要とされるため、従来は、一般に鉄－ニッケル合金又は鉄－ニッケル－コバルト合金が用いられていた。一方、金属ベース10はレーザ

ダイオードで発生した熱を速やかに放散させる必要があるので、銅、銅－タングステン合金等の高熱伝導性金属が用いられていた。金属ベース10と金属枠体２とは銀－銅合金等の金属ろう材により接合されていた。

【０００５】上述のように、従来の半導体装置用金属ケースは金属ベース10と金属枠体２とがそれぞれ異なる金属で構成され、ろう付接合されて構成されていた。しかしながら、金属ベース10と金属枠体２とがそれぞれ異なる金属で構成された従来の半導体装置用金属ケースでは、両者の熱膨張係数の不整合により、接合時に歪み、特に金属ベースが反る変形が生じ易い。

【０００６】この歪みが発生した金属ケースにレーザダイオードを実装すると、レーザダイオードと金属枠体の窓部付近に取り付けた光ファイバーとの間で光軸にずれが生じ、光ファイバへ入射するレーザ出力が低下するという問題がある。また、マイクロ波デバイスを実装した場合には、反りにより、デバイスが破壊されたり、接地電圧の不安定や熱放散性の低下をまねき、デバイスが正常に動作しないという問題があった。

【０００７】上記問題解決のため、従来はろう付け後、金属ケースの金属ベース裏面を研磨し、平坦化して歪み（反り）を修正する等の効率の悪い追加作業を行うこともある。また、上記の歪みを生じさせないために、金属ベース10と金属枠体２とを同一の材料で一体に作製することも考えられる。この場合、その材料としては、ガラス端子やセラミック端子と熱膨張係数が近似し、かつ熱放散性が良好な銅－タングステン合金が用いられてきた。銅－タングステン合金は粉末冶金法で製造され、特に以下に説明する２つの方法がとられる。第１の方法は、所望の組成のCu粉末及びW粉末を混合して成形体とした後、Cuの溶融点以上の温度で焼結を行う焼結法である。また、第２の方法は、予めW粉末を成形した後これを焼結して多孔成形体とし、この多孔成形体の空孔に溶融Cuを溶浸する溶浸法である。

【０００８】上記の焼結法では焼結時の収縮が10%以上と大きいので、成形体が大きく変形する。また、焼結時に成形体の全外周へ溶融Cuがしみ出してしまい、各部の寸法も変化する。一方、溶浸法でも溶浸時に成形体の全外周へ溶融Cuがしみ出す。さらに、Cu－タングステン合金は塑性加工が困難である。また、これらの製造時の問題は、Cu－モリブデン合金でも全く同様である。したがって、例えば図２及び図３に示した金属ベース10と金属枠体２の一体品を作製するには、焼結または溶浸で製造された銅－タングステン合金のブロックから機械加工により削り出すしか方法がなく、コスト高になるばかりでなく、量産性にも乏しかった。

【０００９】一方、半導体装置用金属ヘッダーはレーザダイオードやマイクロ波デバイスを搭載するベースに、電気信号入出力用のガラス端子が取り付けられている。また、必要に応じてベース上には、セラミックよりなる

回路基板が搭載され、気密性を保持する為にふたを溶接する必要のある場合には、ベース上縁部に、鉄系金属よりなる金属縁が取りつけられることもある。図４及び図５にそれぞれ従来の半導体用金属ヘッダーの組立体の一例を示す。

【００１０】図４はレーザダイオード用金属ヘッダーの斜視図であり、図５はマイクロ波デバイス用金属ヘッダーの斜視図である。これらの金属ヘッダーはいずれも、レーザダイオードやマイクロ波デバイス等の半導体素子搭載用の凸部７を備えた金属ベース10にガラス端子で構成された電気信号入出力端子３を取り付けたものである。端子の数は、半導体素子の入出力数に応じて任意であり、金属ベース10の上縁部には気密封止用のふたを溶接するための金属縁５が取り付けられることもある。

【００１１】金属ベース10にはガラス端子と熱膨張係数が近似し、かつ半導体素子より発生する熱を速やかに放散させる必要があるので、一般に銅－タングステン合金が用いられていた。しかしながら銅－タングステン合金で、このような金属ヘッダー用金属ベースを作製する場合にも、上述の焼結時の変形や、Cuのしみ出しが起こるので、所定の寸法に仕上げるためには全外周および半導体素子搭載用の凸部やガラス端子用の穴部の機械加工が必要であり、非常に高価なものとなっていた。

【００１２】上述の半導体装置用金属部品等に使用される銅－タングステン合金や銅－モリブデン合金の粉末冶金法による製造方法は、特開昭59－21032 号公報に開示されている。また、特表平 2－501316号公報には、前記焼結法を改良した押出鋳込法（射出成形法）が開示されている。

【００１３】上記の特表平 2－501316号公報に開示されている方法は、Cu粉末及びW粉末を有機バインダーと混合し、射出成形法により成形体を作製した後、脱バインダー、焼結を行って合金を得る方法である。しかしながら、この方法は既に説明した焼結法の欠点を有する。まず、この方法で所定の密度の合金を得るためには、多孔成形体に含まれていたバインダー量に相当する収縮を生じさせなければならない。従って、半導体装置用金属部品のように形状が複雑な製品の場合には、部位により収縮率に微妙な差が生じ、焼結時に変形し易いので高い形状精度が得られにくい。

【００１４】また、多孔成形体にCu粉末が５～50重量%含まれているため、焼結の際、多孔成形体表面に多量のCuのしみ出し部が形成される。従って、金属ケース、金属ヘッダーのように高い寸法精度や表面形状を要求される製品を製造する場合には、ほとんどの全面を切削加工で仕上げなければならない。

【００１５】さらに、焼結法の場合、合金に空孔が残留することが避けられない。このため、上記の切削加工後のメッキ工程において、メッキの密着不良や、メッキ液の空孔内残留によるメッキの変色が生じたり、空孔部に

メッキが付かない等のメッキの不具合が起こる。また、空孔によって、ケースとふたの間、ケースの開口部における他の部材との接合部等の気密性も損なわれる。加えて、空孔によって合金の熱伝導度も低下するという問題もある。

【0016】一方、溶浸法の場合は、空孔の残留がほとんどないので空孔に起因する問題は回避できる。しかしながら、溶浸法においても成形後、多孔成形体を作製するために焼結を行うと、焼結法ほど大きくはないが少なくとも5％の収縮が起こるため、変形が生ずる。また、前述のように溶融Cuが全外周へしみ出す。このような変形と、しみ出しとが存在すると、全面に切削しろの大きい機械加工仕上げが必要である。これは、形状が複雑な製品ほど重要な問題であり、WまたはMo粉末の射出成形体を作製しても、多孔成形体を作製するために焼結を行い、従来の溶浸法でCuを溶浸させる限り避けられない。

【0017】

【発明が解決しようとする課題】本発明の課題は、以上説明した従来の銅－タングステン合金、銅－モリブデン合金の製品の焼結法及び溶浸法による製造における各種の問題を解決することにある。また、本発明の目的は、上記従来技術の問題点を解決する新規な半導体装置用金属部品、その製造方法及びこの半導体装置用金属部品を使用した信頼性が高い半導体装置を提供することにある。

【0018】

【課題を解決するための手段】本発明に従うと、半導体装置を搭載する金属ベースと、該金属ベースと一体に形成された金属部材とを備える半導体装置用金属部品において、前記金属ベースと金属部材とが、20～50体積％のCuと、1重量％以下のNiとを含み、残部がW及び／又はMoの合金で構成され、少なくとも1面の機械加工されていない面を有し、この面の極く表層部のCu含有量が内部のCu含有量以下であることを特徴とする半導体装置用金属部品が提供される。本発明の半導体装置用金属部品では、前記合金が、1重量％以下のNi粉末を含み、残部がW粉末、Mo粉末、WとMoとの混合粉末又はW－Mo合金粉末である金属粉末の多孔成形体にCuを溶浸して形成された金属組織で構成されていることが好ましい。

【0019】また、本発明においては、1重量％以下のNi粉末を含み、残部がW粉末、Mo粉末、WとMoとの混合粉末又はW－Mo合金粉末からなる金属粉末を射出成形法により成形した後、空孔を20～50体積％含んだ多孔成形体を形成し、この多孔成形体の空孔にCuを溶浸し、最終的な各部の寸法の収縮率を2％以内にして複合合金化することを特徴とする半導体装置用金属部品の製造方法が提供される。本発明の方法では、上記多孔成形体を形成する工程が、前記多孔成形体を形成する工程が、それぞれ平均粒径40μm以下の、Ni粉末と、W粉末、Mo粉末及びW－Mo合金粉末の少なくとも1種とをNi粉末が1重量

％以下となるよう混合して混合粉末とする工程と、該混合粉末を、融点 100℃以下のワックス成分と灰分を殆ど残さない有機物を混合してなる有機バインダーと共に混練する工程と、該混練物を射出成形により成形する工程と、成形したものを脱バインダー処理して空孔を形成する工程とを含むことが好ましい。

【0020】本発明の方法において、脱バインダー処理する工程は、有機溶媒を使用して蒸気洗浄処理する工程と、 500℃以上の温度で加熱処理する工程とを含むことが好ましい。また、

【0021】一方、本発明の方法では、Cuを溶浸する工程の前に、前記多孔成形体の少なくとも1面を除く表面に、溶浸処理時に物理的及び化学的に安定で前記多孔成形体と反応せず、溶融Cuと濡れず、溶浸処理後容易に除去可能である粉末の溶剤混合物を塗布乾燥する工程含み、Cuを溶浸する工程の後に、前記粉末を除去する工程を含むことが好ましい。この粉末は、Al_2O_3、TiO_2、SiO_2、ZrO_2 、AlN、BN、Si_3N_4、TiN、ZrN、SiC、ZrC及びTiCから選択された少なくとも1種の粉末を含むことが好ましい。

【0022】

【作用】本発明の半導体装置用金属部品は、金属ベースと金属部材とが、20～50体積％のCuと、1重量％以下のNiとを含み、残部がW及び／又はMoの合金で構成されている。従って、本発明の半導体装置用金属部品は、高い熱放散性とガラスやセラミックに近似した熱膨張係数を有する。

【0023】本発明の半導体装置用金属部品に使用される合金で、Cuの含有量が19体積％未満のときは、粒子間の内在空孔が発生し易いので緻密化しにくく、その結果熱伝導率がばらつき、安定な合金を得られないため、金属ケースやヘッダーの部品としては適さない。また、Cuの含有量が49体積％を越えると、熱膨張係数が10×10^{-6}／℃を越えるので、金属ケースやヘッダーに組み込まれる電気信号入出力用のガラス端子やセラミック端子との熱膨張差が大きくなり、信頼性の低下をまねくことがある。

【0024】本発明の半導体装置用金属部品に使用される合金は、1重量％以下のNiを含んでもよい。これは、Niにより、Cuの溶浸時に多孔成形体との濡れ性が改善されるからであるが、Niの含有量が1重量％を越えると、合金の熱伝導率が低下するので好ましくない。本発明の半導体装置用金属部品に使用される合金は、上記のCu及びNiを除いた残部がW及び／又はMoであるが、WとMoの割合は任意である。

【0025】本発明の半導体装置用金属部品は、1重量％以下のNi粉末を含み、残部がW粉末、Mo粉末、WとMoとの混合粉末又はW－Mo合金粉末である金属粉末の多孔成形体にCuを溶浸して形成された金属組織で構成されていることが好ましい。W、Mo、Niは、多孔成形体におい

て骨格を形成し、Cuは空孔部に浸透する。従って、W、Mo、Niによる骨格とCu溶浸相による特徴的な複合組織となる。

【0026】本発明では、上記半導体装置用金属部品を粉末射出成形と、溶浸法を組み合せて製造することにより、寸法精度を格段に向上させ、製造コストを低減した。すなわち、本発明の方法は、以下の構成要素を含むことが好ましい。

① 射出成形法によって作製されたW及び／又はMoを主成分とする成形物の、脱バインダー後に生ずる空孔を、Cuの溶浸のための空孔として積極的に使用する。これにより、従来のように射出成形後に行っていた焼結工程において、成形物の空孔を除去し、密度を向上させる必要がなくなり、成形物の収縮を最大でも２％までに抑えることができる。従って、射出成形により作製された成形物の寸法精度が維持される。

② 射出成形により作製された三次元的に複雑な形状の成形物の脱バインダーを完全に行い、Cuの溶浸を確実にするために、有機溶剤の蒸気洗浄による処理と、加熱による処理の２段階の処理を行う。

③ 従来Cuの溶浸後に必須であった機械加工を極力少なくするため、脱バインダー後の多孔成形体に、溶浸後に機械加工を行う場合に最も加工容易であると推定される面（例えば、図２および図３の金属ヘッダーの場合は、ベース10の１端面）を除いて溶出防止剤を塗布し、多孔成形体のこの最も加工容易と推定される面からCuの溶浸を行う。これにより、Cuが溶出するのは溶浸を行った多孔成形体の最も加工容易な面からのみであり、Cuはこの面に選択的にしみ出す。従って、本発明の方法では、製品の最も加工容易な面のみ加工すればよく、寸法精度さえ満足していれば他の面は加工する必要がない。この場合、切削しろも小さい。従って、仕上げのための加工時間が大幅に短縮される。本発明の方法では、上記の構成要素を適宜組み合わせることにより、Cu－W、Cu－Mo、Cu－W－Mo合金よりなる高精度の金属部品を作製する。

【0027】より具体的には、本発明の方法では、１重量％以下のNi粉末を含み、残部がW粉末、Mo粉末、WとMoとの混合粉末又はW－Mo合金粉末からなる金属粉末を射出成形法により成形するので、三次元的に複雑な形状の成形体を高精度で安価に提供することができる。従って、レーザダイオード用の金属ケースやマイクロ波デバイス用の金属ヘッダーのような複雑な形状を有し、且つ高い寸法精度と高い熱放散性が必要とされる金属部品を製造するのに適している。

【0028】また、本発明の方法では金属粉末を成形した後、空孔を20～50体積％含んだ多孔成形体を形成し、この空孔にCuを溶浸させる。この方法では、通常の射出成形法のように脱バインダー後、粉末焼結を行なわないので、射出成形により得られた多孔成形体から最終の部品にいたるまでの工程で、多孔成形体が大きく収縮する

ことがなく、成形金型を高精度に設計することによって、最終の部品の寸法精度を高精度にコントロールすることができる。

【0029】本発明の方法で、上記の多孔成形体の空孔部が20体積％未満の場合、溶浸後のCuの含有率が20体積％未満になり易く、上述のように、Cuの含有率が20体積％未満になると、内在空孔の発生により熱伝導度がばらつき、安定な合金が得られない。一方、空孔部が50体積％を越えると、溶浸後のCuの含有率が50体積％を越え、熱膨張係数が10×10^{-6}／℃を越えてしまう。従って、上記の多孔成形体の空孔部は、20～50体積％とする。

【0030】本発明の方法では、上記多孔成形体を形成する工程が、それぞれ平均粒径40μm以下の、Ni粉末と、W粉末、Mo粉末及びW－Mo合金粉末の少なくとも１種とをNi粉末が１重量％以下となるよう混合する工程と、該混合粉末を、融点 100℃以下のワックス成分と灰分を殆ど残さない有機物を混合してなる有機バインダーと共に混練する工程と、該混練物を所定の三次元配置された金型に注入する射出成形により、最終形状の相似形の成形物を成形する工程と、成形したものを脱バインダー処理して空孔を形成する工程とを含む。有機バインダーを混合、混練する際、そのバインダー量を調整することにより、多孔成形体の空孔を容易に20～50体積％にすることができる。

【0031】本発明の方法では、上記混合粉末にNiが含まれる場合、上述のようにCuの溶浸性（多孔成形体に対するぬれ性）が向上する。ただし、上述のように、混合粉末のNiの含有量が１重量％を越えると、溶浸後の熱伝導率が低下するので好ましくない。

【0032】本発明の方法では、原料となるNi、W、Mo、W－Mo合金の粉末は多孔成形体の密度を向上させ、所望の空孔部に均一にCuを溶浸させるために、平均粒径が40μm以下のものを用いる。さらに、平均粒径が10μm以下のものを用いることが好ましい。

【0033】本発明の方法では、脱バインダー工程は、使用した有機バインダーに対して溶解性を有する有機溶媒での蒸気洗浄を行う工程と、 500℃以上の温度で加熱する工程とを含むことが好ましい。本発明の方法において、上記金属の混合粉末に混練するバインダーは、低融点ワックスと、灰分を殆ど残さない有機物とを混合した有機バインダーである。この有機物は、ワックスの融点では安定な有機物である。上記の脱バインダー工程では、第１段階の有機溶媒の蒸気で洗浄を行う工程でワックス成分を除去し、これによって表面近傍の脱バインダーを行うとともに成形体内部から上記の有機物を除去するための先導孔を形成する。その後、第２段階の加熱工程でこの有機物を分解消失させる。

【0034】上記の蒸気洗浄の工程で使用する有機溶媒としては、有機バインダーの融点又は軟化点よりも低い沸点を有する有機溶媒が好ましい。これは蒸気洗浄時に

成形物の変形を避けるためである。このような有機溶媒としては、例えば、エタノール、アセトン、トリクロロエタン、四塩化炭素、メチレンクロライド等がある。

【0035】一方、上記の加熱工程は、知られているように酸素が含まれない雰囲気で実施されることが好ましい。これは、成形物の酸化を避けるためであり、例えば水素雰囲気中で上記の加熱工程は実施されることが好ましい。

【0036】本発明の方法では、Cuを溶浸する際に全ての表面へCuが溶出することを防止し、溶浸後の成形体を機械加工する場合に最も加工が容易である面のみにCuを選択的に溶出させるために、Cuを溶浸する工程の前に、多孔成形体の上記の面以外の表面に溶浸防止用の粉末を水又は有機溶剤で分散させて塗付乾燥する。この粉末は、溶浸処理時に物理的及び化学的に安定で前記多孔成形体と反応せず、溶融Cuと濡れず、溶浸処理後容易に除去可能な材料の粉末でなければならない。溶浸防止用の粉末として好ましいものとしては、Al_2O_3、TiO_2、SiO_2、ZrO_2、AlN、BN、ZrN、Si_3N_4、TiN、SiC、ZrC及びTiCの粉末が挙げられる。

【0037】本発明の方法は、Cuを含まず、1重量%以下のNi粉末を含み、残部がW粉末、Mo粉末、WとMoとの混合粉末又はW－Mo合金粉末からなる混合粉末を有機バインダーと混練し、射出成形で成形する。この方法で成形物を形成した後、脱バインダーし、できた空孔部にCuを溶浸するため、上記従来の方法のように、バインダー分に相当する収縮を生じさせる必要がない。従って、多孔成形体が、ほとんど収縮せず、また充分な合金密度が得られる。複雑な形状のものでも、高い形状精度、寸法精度が得られる。さらに、本発明の方法では、Cuを溶浸する際に、多孔成形体のCuを選択的に溶出させる面を除いた全ての表面に溶出防止剤（溶出防止用粉末）を塗付する。これにより、多孔成形体の大部分の表面へのCuの溶出を抑えることができる。そのため、上記のCuを選択的に溶出させる面のみを機械加工するだけで、その他の表面は機械加工することなく、所望の製品形状を得ることができる。

【0038】以下、本発明を実施例によりさらに詳しく説明するが、以下の開示は本発明の単なる実施例にすぎず、本発明の技術的範囲をなんら制限するものでない。

【0039】

【実施例】

実施例1

図1に本発明の半導体装置用金属部品の一例であるレーザダイオードモジュール用金属ケースを示す。図1の金属ケースは金属ベース10と金属枠体2が一体に成形されており、金属枠体2前後の金属ベース10には、固定用の取付穴6がそれぞれ設けられている。金属枠体2は、電気信号入出力端子が取り付けられるよう間隙をもって配置された2個の部材21及び22を有し、部材21の前面には

光信号入出力用の窓4が設けられている。以下、本発明の方法で上記金属ケースを製造する工程を説明する。

【0040】最初に、平均粒径3μmのW粉末と平均粒径4μmのNi粉末とをそれぞれ99.9重量%及び 0.1重量%となるよう配合し、混合粉末とした。次に、融点80℃のワックスと分解焼失温度 550℃のポリエチレンとを体積比で75：25になるように混合し、有機バインダーとした。この有機バインダーと、上記W、Ni混合粉末とを体積比38：62となるように混合し、ニーダーで混練した。この混練体を射出成形機に投入して図1に示したレーザダイオードモジュール用金属ケースと相似形の多孔成形体を作製した。

【0041】この多孔成形体をメチレンクロライド（沸点40℃）を用いて5時間蒸気洗浄を行なうことにより、第1段階の脱バインダー処理を行なった後、水素ガス中にて800℃で30分間加熱することにより第2段階の脱バインダー処理を行なった。この脱バインダーされた多孔成形体の外観は、良好で、また各部の形状も維持されており、反り、変形等の歪みもなかった。また、この脱バインダーされた多孔成形体の空孔率は38体積%であった。

【0042】脱バインダー後の多孔成形体の裏面を除いた表面全面に、BN粉末を水で分散させスプレー法により10μmの厚さに塗付した。この多孔成形体を、図1のレーザダイオードモジュール用金属ケースの金属ベース10と同じ長さ、幅に切り出した厚さ1mmの銅板の上に乗せ、水素雰囲気中で連続炉にて、1150℃で銅の溶浸を行なった。溶浸後、各部の寸法を計測したところ、寸法収縮率は0.8％であった。その後、塗付したBN粉末を液体ホーニングで除去し、さらに裏面の溶融銅残渣を平面研磨により除去して、図1のレーザダイオードモジュール用金属ケースが完成した。以上の製造条件・合金密度を表1の試料番号1として、また、熱膨張係数・熱電導率を表2の試料番号1として示す。同様に表に掲載の条件以外の製造条件は上記と同様な条件で作製した金属ケースの例を比較例も含め表1の試料番号2～16に示す。溶浸後の収縮率は、本発明に従った試料では、試料番号10のものが最大で1.8％であった。この収縮は溶浸時に起こり、多孔成形体の空孔率に応じて変化する。空孔率が30%までの多孔成形体はほとんど収縮しないが、空孔率が30%を越えると、この収縮は空孔率の増加に応じて若干増加する。また、本発明者等の溶浸温度および溶浸時間を変えた追加実験によれば、本発明に従った試料では、上記の収縮は最大でも2％までであることが確認された。さらに、この程度のわずかな収縮では、最終的なCu含有量および合金の物性ならびに寸法精度への影響はほとんどないことが確認された。

【0043】

【表1】

	W／Ni比 または Mo／Ni比 (重量比)	バインダー／金属粉末比 (体積比)	1次脱バインダー処理で使用した有機溶媒	2次脱バインダー処理の加熱温度	多孔成形体の空孔率 (体積%)	使用溶出防止剤	合金密度 (n＝50)	溶浸後の収縮率 (%)
1	99.9／0.1	38／62	メチレンクロライド	800℃	38	BN	15.3±0.2	0.8
2	99.0／1.0	20／80	エタノール	800℃	20	ZrO_2	17.2±0.3	0
3	99.5／0.5	20／80	メチレンクロライド	800℃	20	BN	17.2±0.3	0
4	99.6／0.4	28／72	エタノール	600℃	28	TiN	16.4±0.3	0
5	99.6／0.4	28／72	エタノール	600℃	28	Al_2O_3	16.4 ±0.3	0
6	99.7／0.3	35／65	メチレンクロライド	600℃	35	BN	15.7±0.2	0.5
7	99.7／0.3	35／65	メチレンクロライド	550℃	35	BN	15.6±0.2	0.5
8	99.8／0.2	42／58	エタノール	550℃	42	TiN	14.9±0.2	1.0
9	99.8／0.2	42／58	エタノール	600℃	42	TiN	14.9±0.2	1.0
10	99.9／0.1	48／52	メチレンクロライド	600℃	48	AlN	14.3±0.2	1.8
11	99.0／1.0	20／80	エタノール	800℃	20	BN	9.9±0.2	0
12	99.5／0.5	35／65	エタノール	600℃	35	TiN	9.8±0.2	0.2
13	99.9／0.1	49／51	メチレンクロライド	600℃	49	AlN	9.6±0.2	1.5
14	99.5／0.5	18／82	—	—	—	—	—	—
15	99.5／0.5	51／49	—	—	—	—	—	—
16	98.8／1.2	28／72	エタノール	600℃	28	Al_2O_3	6.4±0.3	0

注）試料１～10は、Ｗ－Ni粉末を使用して作製した実施例。試料11～13は、Mo－Ni粉末を使用して作製した実施例。試料14～16は、Ｗ－Ni粉末を使用して作製した比較例。試料14は、型に混練物が100 %充填されず、正常成形密度の成形体が得られなかった。試料15は、脱バインダー時に成形体が発泡し、正常な多孔成形体が得られなかった。

【００４４】合金密度については50個の部品について測定したものであり、ほぼ理論密度通りになっており、脱バインダー及び焼結後の空孔に完全にCuが溶浸したことがわかる。また、断面組織も欠陥がなく、さらに溶出防止剤を塗付していた面にはCuの溶出物が全くみられなかった。表面分析の結果、溶出防止剤により、溶出防止剤を塗付していた面のごく表層（約１μｍ）の部分のCuの含有量は、金属ケース内部に比較してやや小さかったが、これも合金の物性値に影響を及ぼすほどではなかった。

【００４５】おのおのの合金の熱伝導率及び熱膨張係数は、以下の表２に示す通りであり、半導体装置用金属部品としては、充分な特性を示すものである。

【００４６】

【表２】

	熱膨張係数 ($\times10^{-6}$/℃)	熱伝導率 (cal/cm sec℃)
1	8.6	0.51
2	6.5	0.39
3	6.5	0.42
4	7.2	0.45
5	7.2	0.45
6	8.3	0.48
7	8.3	0.48
8	9.1	0.55
9	9.1	0.55
10	9.7	0.63
11	8.0	0.38
12	9.0	0.49
13	10.0	0.57
16	7.2	0.30

【００４７】実施例２
表１の６のレーザダイオードモジュール用金属ケースの寸法精度と、同一Cu量で特表平２－501316号公報に開示されている従来の方法で製造したもの（比較例１）の寸法精度とを以下の表３に示す。

【００４８】表３において、「ろう付け後そり」は、図２に示した、セラミックス端子３及び金属縁５がろう付けされた、レーザダイオードモジュール用金属ケース組立体のそりを示す。この値のみ、表１の５の本発明の方法で製造された本発明のレーザダイオードモジュール用金属ケースを使用したもの、特表平２－501316号公報に開示されている従来の方法で製造した金属ケースを使用したもの（比較例１）及び特開昭59－21032 号公報に開示されている従来の方法で得られる銅タングステンに合金を機械加工して金属ベースを作製し、鉄、ニッケル・コバルト合金で構成された金属枠体をロウ付して製造した金属ケースを使用したもの（比較例２）についてそれぞれ示されている。

【００４９】
【表３】

要求寸法 (単位：mm)		金属ベース 長さ	金属ベース 幅	金属ベース 厚さ	金属ベース 取付穴径	金属ベース ろう付後そり	金属枠体 長さ	金属枠体 幅	金属枠体 高さ
		32±0.15	12.7±0.1	1.0±0.05	2.64±0.05	0.015Max	20.80±0.15	12.7±0.1	8.0±0.1
本発明の寸法公差	6－1	31.96	12.71	1.01	2.64	0.005	20.80	12.71	8.03
	6－2	31.96	12.72	1.01	2.63	0.003	20.79	12.72	8.02
	6－3	32.01	12.69	1.02	2.66	0.005	20.76	12.69	7.99
	6－4	32.05	12.70	0.99	2.65	0.001	20.83	12.70	8.01
	6－5	32.02	12.68	0.98	2.62	0.003	20.85	12.68	7.97
	6－6	32.03	12.68	1.00	2.65	0.005	20.81	12.68	8.01
	6－7	31.98	12.70	1.00	2.66	0.004	20.82	12.70	8.00
	6－8	31.99	12.73	1.02	2.64	0.004	20.84	12.73	7.96
	6－9	32.00	12.71	0.98	2.62	0.003	20.81	12.71	7.99
	6－10	32.01	12.70	1.00	2.64	0.002	20.80	12.70	8.02
	平均	32.001	12.702	1.001	2.641	0.004	20.811	12.702	8.000
	R	0.090	0.050	0.040	0.040	0.004	0.090	0.050	0.070
	σ	0.028	0.015	0.014	0.014	0.001	0.025	0.015	0.021
比較例1	平均	32.010	12.69	1.00	2.65	0.012	20.81	12.69	7.99
	R	0.12	0.08	0.05	0.05	0.08	0.11	0.08	0.04
	σ	0.049	0.034	0.026	0.025	0.030	0.043	0.034	0.026
比較例2	平均	――	――	――	――	0.032			
	R	――	――	――	――	0.017			
	σ	――	――	――	――	0.048			

【0050】次に上記本発明のレーザダイオードモジュール用金属ケースと比較例1および2のレーザダイオードモジュール用金属ケースとを使用して、図2に示すよう、セラミック端子3および金属縁5をろう付けし、レーザーダイオードモジュール用金属ケース組立体を作製した。各組立体それぞれの表面に厚さ1.5μmのニッケルメッキを施し、さらにその上から厚さ1.5μmの金メッキを施し、窓4にサファイア製の窓材をAu－Snハンダで封着した。この状態でメッキの耐熱性（大気中 450℃ 5分保持後のメッキの劣化状況確認）、ヒートサイクル（－65℃×10分⟷＋150℃×10分）100回後の気密性の評価を、それぞれの項目について200個ずつの金属ケース組立体を用いて行った。

【0051】耐熱性については上記高温保持後の外観を20倍の光学顕微鏡によって枠体部長手方向側面の膨れ、しみ、変色等の不具合および従来品では特にベース部と枠体部のロウ付け部の変色についてチェックした。気密性の評価方法を図6に示す。気密性の評価は、レーザーダイオードモジュール用金属ケース組立体1を金属枠体2を下にしてOリング42を介して真空吸引用フランジ41にセットし、ケース内を排気した後、外部からHeガスを吹きつけて前記フランジを通してHeリークディテクターによってリーク量を確認する方法で行った。この方法によってリーク量5×10^{-8} atm cc／sec 以下のものを合格としてそれ以上のものを不合格とした。それぞれの結果を表4に示す。

【0052】

【表4】

評価項目	実施例（各 200個）	比較例1（各 200個）	比較例2（各 200個）
メッキの耐熱性（上段が枠体部側面の不具合品数、下段がベースと枠の間のロウ付け部の変色不具合品数）	0	4	0
	0	0	0
ヒートサイクル後の気密性（不合格品数）	0	2	0
サーマルショク後の気密性（不合格数）	0	2	0

【0053】表4に示したように、比較例1については金属枠体側面の耐熱性不良およびヒートサイクル不良、およびサーマルショク不良が発生したのに対し、本発明による製品は全く不具合がなかった。尚、本発明品のリーク量はいずれも 1×10^{-9} atm cc／sec 以下であった。比較例1のヒートサイクルおよびサーマルショクで発生した気密不良は、金属ケースに空孔があるために発生したものと推定される。

【0054】次に上記と同じ組立体を使用して、実際にレーザーダイオードを実装し、図7に示すよう、取付穴6を使用してボルト24でCuの放熱板23に締め付けて止め、さらに光ファイバ26でパワーメーター25に結合し＊＊た。この締め付け固定の前、すなわち、軽く放熱板上に保持した状態と完全に固定した状態とで同じ入力光量 W_0 を投入して固定前後の光ファイバーに対して出力される光量 W_1 、 W_2 を測定し、出力低下率（ $W_1 - W_2$ ）／ W_1 （％）を算定し、その結果を合わせて表5に示した。このデータより本発明の金属ケースを使用した組立体に比べ、従来の金属ケースを使用した組立体は、明らかにケース自体の反りと歪みがあるため、締め付け後光軸のズレが生じ、出力低下の大きいことがわかる。

【0055】

【表5】

	本発明の金属ケース	比較例1の金属ケース	比較例2の金属ケース
出力低下率	1％以下	1～7％	1～10％

本発明の金属ケースを使用した半導体装置は、従来のものを使用したものに比較して優れた性能を発揮することがわかる。

【0056】

【発明の効果】以上詳述のように、本発明に従うと、良好な熱放散性、搭載する半導体や他のセラミック、ガラス部品と近似した熱膨張係数を有し、高い信頼性及び寸法精度を実現した新規な半導体装置用金属部品、その製造方法及びこの半導体装置用金属部品を使用した半導体装置が提供される。本発明の金属部品は、金属ベースと他の金属部材とを一体化することにより、製造作業を簡素化することが可能である。また、従来のような金属ベースと金属枠体との間の接合による反りの発生、接合部の品質問題も解消される。本発明の方法で製造された本発明の半導体装置用金属部品は、寸法精度が高いので、殆どの部分で素材を追加切削加工する必要がなく、製造コストが大幅に低減できる。さらに、本発明の半導体装置用金属部品を使用することにより、信頼性の高い半導体装置が安定して製造できる。

【図面の簡単な説明】

【図1】本発明の半導体装置用金属部品の一例であるレーザダイオードモジュール用金属ケースの斜視図。

【図2】従来のレーザダイオードモジュール用金属ケース組立体の斜視図。

【図3】従来のレーザダイオードモジュール用金属ケース組立体の他の例の斜視図。

【図4】半導体装置用金属部品の一例であるレーザダイオード用金属ヘッダーの斜視図。

【図5】半導体装置用金属部品の一例であるマイクロ波デバイス用金属ヘッダーの斜視図。

【図6】実施例で行った気密性試験方法を示す図である。

【図7】実施例で行ったレーザー出力測定法を示す図である。

【符号の説明】

1 金属ケース

2 金属枠体

3 電気信号入出力端子

4 窓

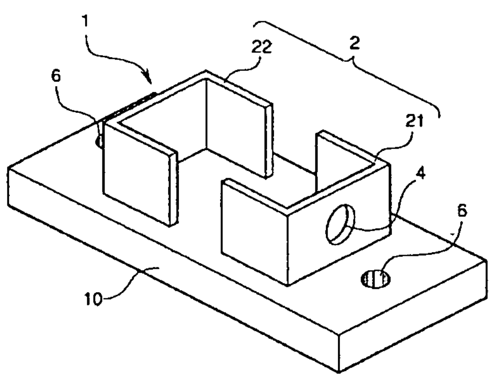
5 金属縁

6 取付穴

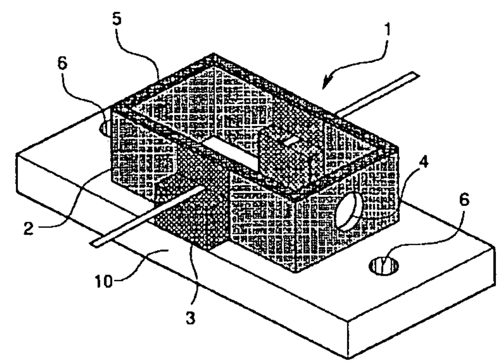
7 半導体素子搭載用凸部

10 金属ベース

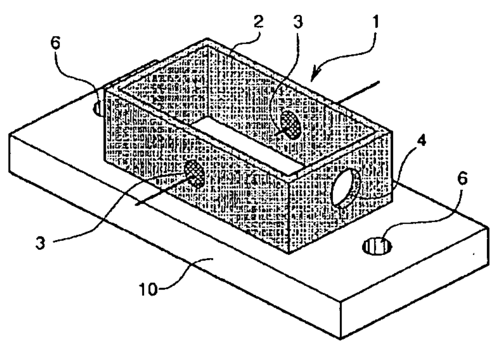
【図1】



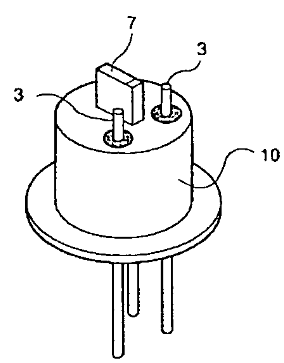
【図2】



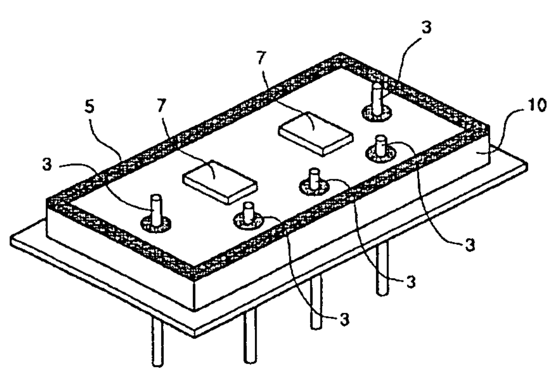
【図3】



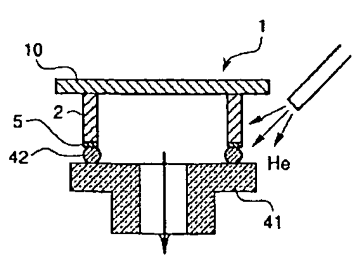
【図4】



【図5】



【図6】



【図7】